

WHAT IS CLAIMED IS:

1. A magnetoresistive element comprising a ferromagnetic double tunnel junction having a stacked structure of a first antiferromagnetic layer/a first ferromagnetic layer/a first dielectric layer/a second ferromagnetic layer/a second dielectric layer/a third ferromagnetic layer/a second antiferromagnetic layer; and

10 the second ferromagnetic layer consisting of a Co-based alloy or a three-layered film of a Co-based alloy/a Ni-Fe alloy/a Co-based alloy.

2. The magnetoresistive element according to claim 1, wherein a thickness of the Co-based alloy or the three-layered film of the Co-based alloy/the Ni-Fe 15 alloy/the Co-based alloy is 1 to 5 nm.

3. A magnetic memory device, wherein memory cells each comprising the magnetoresistive element according to claim 1 and a transistor or a diode are arrayed.

20 4. The magnetic memory device according to claim 3, wherein at least the uppermost antiferromagnetic layer of the magnetoresistive element constitutes a part of a bit line.

25 5. A magnetoresistive element comprising a ferromagnetic double tunnel junction having a stacked structure of a first ferromagnetic layer/a first dielectric layer/a second ferromagnetic layer/a first

antiferromagnetic layer/a third dielectric layer/a second dielectric layer/a fourth ferromagnetic layer; and

the first and fourth ferromagnetic layers
5 consisting of a Co-based alloy or a three-layered film of a Co-based alloy/a Ni-Fe alloy/a Co-based alloy.

6. The magnetoresistive element according to claim 5, wherein a thickness of the Co-based alloy or the three-layered film of the Co-based alloy/the Ni-Fe
10 alloy/the Co-based alloy is 1 to 5 nm.

7. A magnetic memory device, wherein memory cells each comprising the magnetoresistive element according to claim 5 and a transistor or a diode are arrayed.

8. A magnetoresistive element comprising a
15 ferromagnetic double tunnel junction having a stacked structure of a first antiferromagnetic layer/a first ferromagnetic layer/a first dielectric layer/a second ferromagnetic layer/a second antiferromagnetic layer/a third ferromagnetic layer/a second dielectric layer/a fourth ferromagnetic layer/a third antiferromagnetic
20 layer; and

the first and fourth ferromagnetic layers or the second and third ferromagnetic layers consisting of a Co-based alloy or a three-layered film of a Co-based
25 alloy/a Ni-Fe alloy/a Co-based alloy.

9. The magnetoresistive element according to claim 8, wherein a thickness of the Co-based alloy or

the three-layered film of the Co-based alloy/the Ni-Fe alloy/the Co-based alloy is 1 to 5 nm.

10. A magnetic memory device, wherein memory cells each comprising the magnetoresistive element according
5 to claim 8 and a transistor or a diode are arrayed.

11. A magnetic memory device according to
claim 10, wherein at least the uppermost
antiferromagnetic layer of the magnetoresistive
element constitutes a part of a bit line.

10 12. A magnetoresistive element comprising a
ferromagnetic double tunnel junction having a stacked
structure of a first ferromagnetic layer/a first
dielectric layer/a second ferromagnetic layer/a first
nonmagnetic layer/a third ferromagnetic layer/a second
15 nonmagnetic layer/a fourth ferromagnetic layer/a second
dielectric layer/a fifth ferromagnetic layer;

the second, third and fourth ferromagnetic layers
adjacent to each other being antiferromagnetically
coupled through the nonmagnetic layers; and

20 the first and fifth ferromagnetic layers
consisting of a Co-based alloy or a three-layered film
of a Co-based alloy/a Ni-Fe alloy/a Co-based alloy.

13. The magnetoresistive element according to
claim 12, wherein a thickness of the Co-based alloy or
25 the three-layered film of the Co-based alloy/the Ni-Fe
alloy/the Co-based alloy is 1 to 5 nm.

14. A magnetic memory device, wherein memory cells

each comprising the magnetoresistive element according to claim 12 and a transistor or a diode are arrayed.

15. A magnetic memory device comprising a first magnetization pinned layer whose magnetization direction is pinned, a first dielectric layer, a magnetic recording layer whose magnetization direction is reversible, a second dielectric layer, and a second magnetization pinned layer whose magnetization direction is pinned;

10 the magnetic recording layer comprising a three-layered film of a magnetic layer, a nonmagnetic layer and a magnetic layer, the two magnetic layers constituting the three-layered film being anti-ferromagnetically coupled; and

15 magnetization directions of the two magnetization pinned layers in regions in contact with the dielectric layer being substantially anti-parallel to each other.

16. A method for writing information to the magnetic memory device according to claim 15, comprising steps of: supplying the magnetic recording layer with a spin current through the first or second magnetization pinned layer; and flowing a current in a wire for writing so as to apply a current magnetic field to the magnetic recording layer.

25 17. A magnetic memory device comprising a first magnetization pinned layer whose magnetization direction is pinned, a first dielectric layer, a

magnetic recording layer whose magnetization direction is reversible, a second dielectric layer, and a second magnetization pinned layer whose magnetization direction is pinned;

5 the magnetic recording layer comprising a three-layered film of a magnetic layer, a nonmagnetic layer and a magnetic layer, the two magnetic layers constituting the three-layered film being antiferromagnetically coupled;

10 the second magnetization pinned layer comprising a three-layered film of a magnetic layer, a nonmagnetic layer and a magnetic layer, the two magnetic layers constituting the three-layered film being antiferromagnetically coupled;

15 a length of the first magnetization pinned layer being formed longer than those of the second magnetization pinned layer and the magnetic recording layer; and

20 magnetization directions of the two magnetization pinned layers in regions in contact with the dielectric layer being substantially anti-parallel to each other.

18. A magnetoresistive element comprising a ferromagnetic double tunnel junction having a stacked structure of a first antiferromagnetic layer/a first ferromagnetic layer/a first tunnel insulator/a second ferromagnetic layer/a first nonmagnetic layer/a third ferromagnetic layer/a second nonmagnetic layer/a fourth

ferromagnetic layer/a second tunnel insulator/a fifth ferromagnetic layer/a second antiferromagnetic layer;

the second and third ferromagnetic layers being antiferromagnetically coupled through a first
5 nonmagnetic layer; and

the third and fourth ferromagnetic layers being antiferromagnetically coupled through a second nonmagnetic layer.

19. A magnetic memory device, wherein memory cells
10 each comprising the magnetoresistive element according to claim 18 and a transistor or a diode are arrayed.